A Provincial Strategy
for
Bone Health
and
Fracture Prevention

Recommendations of the Bone Health and Fracture Prevention Steering Committee
January 2001

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A Provincial Strategy for Bone Health and Fracture Prevention

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January, 2001

Foreword

The Ministry of Health and Ministry of Responsible for Seniors is pleased to introduce the following provincial strategy put forth by the Bone Health and Fracture Prevention Steering Committee. This strategy serves an important purpose; it provides research-based information and suggestions for everyone involved in health planning and management.

The Ministry is committed to the development of a provincial strategy for bone health and fracture prevention. Osteoporosis and the issues surrounding this debilitating disease are a concern for people of all ages, women in particular. It is our hope that the provincial strategy outlined ahead will assist educators, health authorities and the public alike to think broadly on bone health.

Corky Evans,
Minister of Health and
Minister Responsible for Seniors

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Preface

Over the last ten years, osteoporosis has gone from being virtually unrecognised by the public to being a source of significant concern and even fear, particularly to women in their midlife and senior years. The morbidity, mortality, and cost to the health care system resulting from poor bone health, falls, and fractures, is significant and certainly a legitimate source of concern. However, as we plan our strategies to deal with these issues, it is crucial that we understand conceptually that the solutions to promoting bone health and preventing fractures cut across the lifespan, involve whole communities, and require a cross-sectoral approach. In other parts of Canada, major "osteoporosis" initiatives have been launched, with the predominant focus being on diagnosis and medical intervention. In British Columbia, recognising this as a population health issue, we have chosen to take a health promotion approach to our Bone Health and Fracture Prevention Strategy. Our strategy builds on existing research and is inclusive of the many sectors involved in addressing these issues successfully. Our steering committee had a broad representation of experts from many of these sectors. Our Plan was to produce a pragmatic, evidence-based document which would be useful to our health authorities, our school boards, and our community planners, as well as the public in B.C. and Canada. It is our sincere hope that this document will be the platform for cohesive provincial policy and a plan of action in this important area of health and wellness in British Columbia.

Dr. Penny Ballem
Vice President, Women's and Family Health Programs
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Introduction

Bone health is an important issue for all British Columbians. Osteoporosis has received much attention from the media and from the pharmaceutical industry. For this reason, bone health is sometimes regarded as an issue that only concerns post-menopausal women. However, people of any age can be affected by poor bone health. The steps needed to ensure good bone health during much of the lifespan are relatively simple; good nutrition and physical activity help children, adolescents, and adults develop and maintain strong bones. In seniors, bone strength declines as a natural part of ageing, but if proper precautions are not taken, this decline can accelerate, resulting in the condition known as osteoporosis. In the senior population, physical activity and nutrition are also essential to prevent accelerated decline of bone strength. In addition, and equally important, the prevention of falls in seniors is a critical part of fracture prevention; intervention with drug therapies may also be necessary in specific individuals. The fractures that result from poor bone health and falls lower the quality of life for many people and place an enormous burden on the health care system. For example, in B.C. alone, there were 2,299 hip fractures during 1998; 75% of these injuries were experienced by women (1). Most of these fractures result from falls, and between 1991/92 and 1995/96, the average length of stay in hospital for fall-related injuries was approximately 17 days for seniors over 65 (2). It is evident that creating a bone health and fracture prevention strategy is essential to improving the quality of life of the growing senior population, as well as reducing costs to the health care system.

The purpose of this document is to articulate a strategy for integrating bone health and fracture prevention research with community action and public policy. In this document, we provide the information that is needed to create a pro-active, comprehensive, evidence-based strategy and provide a link between bone health, falls and fractures, and currently existing health initiatives. Programs that address building optimal bone mass during the childhood and adolescent years, preserving bone during adulthood, and minimising the risk of falls and fractures in seniors are highlighted. We envision that communities will use the information provided to evaluate their needs and to make informed choices about the programs and initiatives that will address this important health issue in their community.

Overview of Research on Bone Health, Osteoporosis, and Fracture Prevention

Introduction

Bone health is a lifespan issue. A large percentage of peak adult bone mass is acquired during childhood and adolescence, is maintained throughout early and middle adulthood, and inevitably diminishes later in life. Although genetics explains approximately 60% of adult peak bone mass, modifiable lifestyle factors account for the remaining 40%. Indeed, poor lifestyle habits may inhibit our ability to reach our optimum genetic potential for bone mass. Other medical risk factors may contribute to accelerated bone loss, with resulting osteopenia or osteoporosis, as well as to increased susceptibility to fracture. Evidence is mounting to support childhood and adolescence as critical periods for bone mass maximisation (3, 4, 5). Given the inevitable loss of bone in old age and the limited success of measures to stay this loss, the early years are deemed a crucial time for positive lifestyle intervention.

The following section provides a brief overview of some of the important findings in the area of bone health, osteoporosis, and fracture prevention.

Bone Health

Lifespan Issues

Adult bone mass is, at any time, a function of the bone accrued during the growing years and the amount of bone lost with advancing age. As low adult bone mineral density (BMD) is one important factor associated with fracture risk (6), it is clear that bone mass accrual during the growing years should be optimised. Modelling is responsible for altering the shape and mass of bones and for the turnover of bone during growth. During modelling, bone accrual outweighs bone absorption, resulting in a net gain of bone over time (7). Remodelling is a replacement process, during which an activation phase is followed in sequence by a resorption and a formation phase. Although remodelling is the dominant process affecting bone shape and mass in adults, it also occurs during growth. The net result of remodelling is to lose or maintain, but not to gain, bone (8).

Figure 1: Bone Mineral Accrual for Girls and Boys

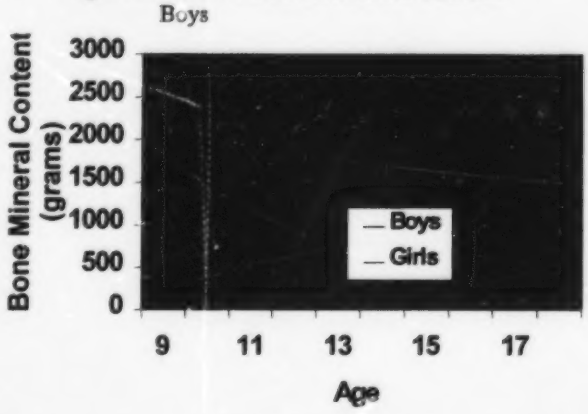
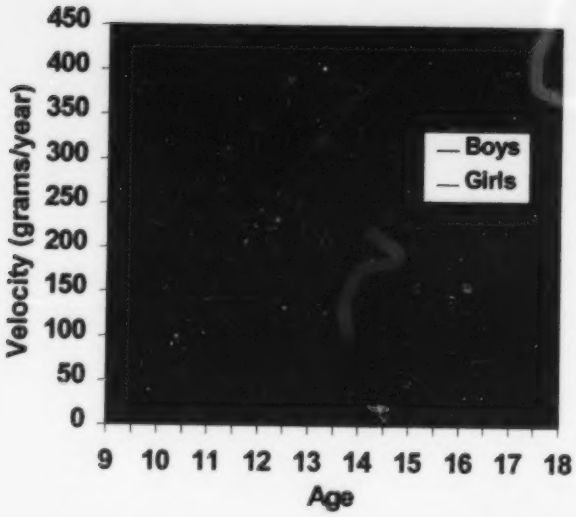


Figure 2: Velocity of Bone Mineral Accrual for Girls and Boys



Important new information on the pattern of bone mineral accrual comes from a longitudinal study of boys and girls at the University of Saskatchewan. The bone density of approximately 200 boys and girls has been measured yearly for seven years (5, 9). Figure 1 illustrates the normal pattern of bone mineral accrual for boys and girls at the 50th percentile between the ages of 9 and 18 years. Figure 2 is a velocity curve and shows the pattern of peak bone mineral accrual for boys and girls. The importance of the adolescent years for bone

> Over 25% of peak bone mass is accrued in the two years around peak linear growth, which occurs at the mean age of 12.69 years for girls, and 14.11 years for boys.

health is emphasised by the finding that over 25% of adult peak bone mass is accrued in the 2 years around peak linear growth (5). (Peak linear growth, the period when the fastest gains in height are made, occurs in girls at a mean age of 12.64 years and in boys at 14.11 years). This is a significant finding as this represents the amount of bone that most individuals will lose in their adult lives (ages 50-80 years) (10). At least 90% of adult bone mass is achieved by the end of adolescence, after which gains are relatively small (5, 11, 12).

Factors, such as dietary calcium and vitamin D, body weight, and sex hormones, also influence skeletal health. Negative associations have been made between bone mass and such factors as smoking and high caffeine and phosphorous intake (12).

This section has provided a brief overview of the development and maintenance of bone over the lifespan. The following sections address issues that affect this process, such as nutrition and physical activity, and factors that interfere with building strong bones.

Nutrition

Nutrition plays a central role in normal growth and development. A balanced diet with adequate nutrient and caloric intake is necessary for general health. In particular, bone health requires sufficient calcium and vitamin D intake. Calcium is the nutrient most important to bone deposition, attainment of peak bone mass, and prevention of bone loss.

Approximately 50% of Canadian adolescent girls are on low-calorie diets, making it extremely difficult to obtain the required calcium intake (12). In fact, most children do not meet the recommended levels of calcium intake. American studies estimate that only 25% of boys and 10% of girls receive the appropriate amount of calcium (13).

American studies estimate that only 25% of boys and 10% of girls receive the appropriate amount of calcium.

Many calcium intervention studies have been conducted in both children and adults, and dietary intake recommendations have been made for various age groups (Appendix). In paediatric groups, calcium supplementation appears to enhance BMD (11, 14, 15, 16), but benefits are not fully sustained when supplementation ceases. These results may indicate the need to sustain high calcium intakes in order to obtain maximal benefit. In adult groups, calcium supplementation to recommended intake levels positively impacts bone health and may reduce fracture risk (17), but intakes above recommended levels provide no further benefits (18).

Dairy products are the main source of calcium in North America and provide about 75% of Canadians' calcium intake. It is difficult to meet dietary recommendations for calcium if dairy products are excluded from the diet. However, alternate sources include fortified foods (e.g. calcium-fortified orange juice and soy beverages, tofu made with added calcium), canned salmon (if bones are consumed), and certain deep green vegetables, such as collards and kale. Dietary calcium supplements may be a consideration for those who do not consume dairy products.

One nutrient required for good bone health is vitamin D, which facilitates the absorption of calcium. Milk is fortified with vitamin D, and so young children consuming recommended amounts receive adequate quantities. However, as the consumption of dairy products decreases in the teenage years, or in populations where dairy products are not food staples or where exposure to sunlight is low, vitamin D intake may be inadequate. Vitamin D status is receiving increased attention with regard to its role in bone health. This is because many people have low dietary intakes, and sunlight exposure cannot be relied upon to maintain adequate vitamin D status.

For example, in most of Canada between November and early March, sunlight intensity is not strong enough to allow vitamin D to be manufactured in the skin.

There is great deal of debate about the effect of sunscreen use on vitamin D. Sunscreen may disrupt cutaneous vitamin D synthesis. While theoretically decreasing melanoma risk (sunscreen users may compensate for this use by remaining longer in the sun and, in turn, increasing risk), this disruption may lead to vitamin D deficiency and thus affecting bone health. While much more research is needed, current advice includes using a sunscreen, limiting exposure to the sun and ensuring vitamin D needs are met (19, 20).

Some nutrients have a positive effect on calcium metabolism, including lactose, potassium, and magnesium. Other common dietary components, however, actually have a negative impact on calcium metabolism, such as protein, caffeine, sodium, oxalic acid, phytic acid, and fibre (12). It is important to be aware that most of these dietary constituents are usually only problematic when dietary calcium intake is low. For example, caffeine is not an issue when calcium intake is adequate, but if someone has both a high caffeine intake and a low calcium intake, it can be a risk. Other nutrients, such as phosphorus, are beneficial to calcium metabolism until a critical point at which they become detrimental (12). It is therefore critical to maintain a balanced diet, avoiding excessive intake of any one nutrient.

Protein warrants special comment. Although excess protein may be detrimental to bone, adequate protein is important for bone health. Some older adults have marginal protein intake to begin with, and may attempt to reduce these even further when they learn they have osteoporosis or osteopenia. This is not advisable, as low protein intake can lead to loss of muscle mass and can compromise immune function (21, 12). Furthermore, hip fracture patients have been shown to recover more quickly and to lose less bone mass over time when they receive protein supplements (22).

It is well established that low body weight is a risk factor for fracture.

Dieting and eating disorders are nutrition issues that should also be commented on. Although obesity is a growing problem in Canada, many people, particularly women, are attempting to lose weight even though their weight is within the healthy range. It is well established that low body weight is a risk factor for fracture; thus, dieting should be discouraged in those for whom it is not warranted for health reasons. This issue may be of greatest concern in young adolescents who should be gaining bone. An ongoing study by the B.C. Centre of the Canadian Multicentre Osteoporosis Study (CaMOS) has shown that recurrent dieting despite weight regain is associated with lower bone density and high risk for osteoporosis and fragility fractures (23).

Ethnicity

Bone health, specifically calcium intake, bone geometry and BMD, may differ according to ethnicity. Important to remember, however, is that while certain groups appear more at risk for fracture, lifestyle factors such as physical activity and calcium intake are important for the bone health of all ethnic groups. For what is known, however, there is a great need for further research into the area of ethnic differences in bone health and fracture risk. The following differences have been noted in the literature:

- The prevalence of osteoporosis is lower in Black and Native North American women than in Caucasian women (24).
- Before puberty, Black and White girls had similar bone density levels. Following puberty, while both groups had gains in bone density levels, Blacks had greater increases (24).

- Calcium needs may vary by ethnicity; people of African and Hispanic descent, for example, more often than Caucasians, develop lactase nonpersistence, a loss of enzymes needed to digest the lactose in dairy products. The lower incidence of osteoporosis in these groups may suggest a lower need for calcium (25).
- Ethnic differences in BMD levels have been reduced or eliminated when height and weight are taken into account in the calculation (26).
- Japanese and Chinese women tend to have lower BMD levels and faster decline of bone mass after menopause than Caucasians (27 and 28). The Chinese tend to have lower rates of fracture (28), but the Japanese show higher prevalence of spinal fracture (27) than Caucasians.
- The 'geometry' of the hip can affect fracture susceptibility. Asians (29) and people of African origin (30) have a shorter hip axis than Caucasians, possibly explaining the greater risk of hip fracture in the latter.
- Finally, it is apparent that people who live in areas of China that practice dairying (and thus have higher calcium intakes) have higher bone density than people who live in parts of China with lower calcium intakes (28).

Physical Activity

The benefits of physical activity throughout life for overall health are well established. Regular physical activity is linked to the prevention of numerous diseases, and it is generally accepted that maintaining good physical fitness increases feelings of well-being.

Adequate exercise is particularly important for bone health. The *mechanostat* theory states that bone adapts to the loads it experiences by adding or removing bone mineral as appropriate (8).

When bones undergo stress due to physical activity, bone mass increases. Conversely, bone mass decreases during periods of inactivity.

The stresses and strains of physical activity on young growing bones are strong stimuli for bone modelling, emphasising the importance of physical activity early in life (31). Physical activity, among other factors, during childhood and adolescence influences bone mineral accretion and helps to determine peak bone mass (32). For example, recent exercise intervention studies with prepubertal girls have demonstrated 1-5% higher bone mineral content in exercising groups as compared to control groups (33).

While activity during youth has the greatest impact on achieving peak bone mass, exercise during the adult years is primarily directed toward maintaining good bone health and preventing deterioration. Numerous studies support a positive effect for strength training interventions in pre- and postmenopausal groups (34,

35, 36, 37).

Physical activity in the senior years may moderately slow the decline in bone mass (13). More importantly, it also increases strength and muscle mass, as well as improving general function, and consequently quality of life. American clinical trials have shown a 25% reduction in the risk of falls as a result of physical activity (13). While there have been no studies examining the effect of activity on fracture rates in seniors, it seems reasonable that the decrease in falls as a result of exercise would correlate with a decrease in fractures. Physical activity programs that are specifically designed for seniors teach appropriate exercises that seniors can then continue on their own. These programs can also help to alleviate feelings of isolation common in seniors and provide opportunities for meeting others with whom to exercise.

Physical Activity Programs for Seniors Include:
Osteofit,
Changing Aging,
Joints in Motion

There is overwhelming evidence supporting the impact of physical activity on bone health. However, girls and women in Canada tend to become less active during adolescence, a trend that continues into adulthood, to the detriment of their bone health.

> The involvement of young girls in physical activity decreases from 33% before the age of twelve, to 25% during the high school years, and then further decreases to 11% involvement by the age of 17 (38).

There is also research to suggest that the programs available in many communities are not appealing to women and girls (39). Fortunately, Canada is a world leader in the development of gendered programming in physical activity and there are clear opportunities to build on this expertise.

Factors Interfering with Building Strong Bones

Bone health depends on good nutrition and regular physical activity, but there are other factors that may put the development of healthy bones at risk. For example, some diseases, such as cystic fibrosis, celiac disease, and inflammatory bowel disease, are associated with poor calcium absorption, and therefore, result in low bone mass (13). In addition, the use of glucocorticoids (cortisone-like drugs) for the treatment of many chronic diseases is known to be associated with a significant risk of osteoporosis.

In adolescents and women in their reproductive years, conditions associated with abnormal menstruation, particularly infrequent or absent ovulation, are significant risk factors for early onset osteoporosis (13).

Girls and young women who have low body weight, often related to eating disorders, and young athletes who participate in extremely strenuous training programs, are particularly prone to irregularities of ovulation.

Premature menopause, whether it is surgically- or medically-induced (e.g., following chemotherapy), is also associated with a risk of osteoporosis.

Other genetic and lifestyle factors, such as race, family history of osteoporosis, history of prior fracture, smoking, and excessive consumption of alcohol, can all increase the risk of poor bone health in the midlife years (13, 40). Osteoporosis is often regarded as a woman's disease, and while post-menopausal women do bear the burden of this disease, accelerated bone loss is a problem for ageing men as well as women (41).

The next section discusses the diagnosis, consequences, and treatment of osteoporosis.

Osteoporosis

Definition

The World Health Organisation (WHO) defines osteoporosis as "a systemic skeletal disease characterised by low bone mass and microarchitectural deterioration of bone tissue, with a consequent increase in bone fragility and susceptibility to fracture" (42). However, since there is no accurate measure of microarchitectural deterioration, the operational definition endorsed by the WHO is bone density 2.5 standard deviations below the mean for young, white, adult women (13). This definition is subject to controversy for many reasons. First of all, the validity of a process measuring older women on a scale determined by the bone density of young women has been questioned. Secondly, the relevance of the definition to men, children, and ethnic groups has not been made clear. However, the WHO definition is, to date, the most recognised and accepted definition of osteoporosis.

Fractures are the typical manifestation of osteoporosis, commonly involving the wrists, ribs, vertebrae, and hips. These fractures result in pain, immobility, and decreased quality of life. However, it is critical to remember that not all fractures are related to osteoporosis.

Patients with **normal** bone density account for more than half of hospital admissions due to fractures.

Thus, it is important to acknowledge that hip fractures are not a direct result of bone loss, but rather, of falls. Therefore, fall prevention is an integral part of maintaining good bone health and preventing fractures in old age.

Risk Factors

As discussed above there are many risk factors for osteoporosis, including biological, medical, and lifestyle factors. Naturally, the factors that prevent healthy bone development are also risks for osteoporosis. The table below summarises examples of risk factors for osteoporosis (12).

Table 1: Risk Factors for Osteoporosis

Biological Factors	Medical Factors	Lifestyle Factors
Age, Gender	Hypogonadal states	Low calcium and/or Vitamin D intake
Low peak bone mass	Hormone malabsorption	Inactivity
Thin, small-boned body type	Use of some medications	Excessive alcohol consumption
	Eating disorders	Smoking

Since some of the factors cannot be altered, it is important to focus prevention efforts on those that can be changed.

Diagnosis of Osteoporosis and Prevention of Osteoporosis-Related Fractures

The diagnosis of osteoporosis is often made when an osteoporotic fracture has occurred. Standard x-rays and bone density measurements are currently used to confirm the diagnosis. As of yet, there is no technique that is sufficiently effective and inexpensive to allow for bone measurement as a screening tool. However, the technology of bone density measurement is evolving and this situation may change. Bone densitometry in Canada, at present, is most often done with dual-energy x-ray absorptiometry (DXA), which measures BMD (the true mass of bone). DXA does not discriminate clearly between those who will and will not sustain osteoporotic fractures, however it can be used to assess *risk* of fracture. An in-depth review by the B.C. Office of Health Technology Assessment supported this finding (43). Based on this evidence, the B.C. Medical Association and MSP guidelines committee created a set of guidelines governing the use of DXA (See Appendix for a description of the new protocol).

There are other methods of measuring BMD. Quantitative computed tomography (QCT) provides a three-dimensional measurement of bone density using a regular CT scanner. However, this method exposes patients to higher radiation levels than does DXA and is more expensive. Quantitative ultrasound is receiving a great deal of attention in research as a bone density measure that does not use radiation, but its correlation with fracture risk

is still uncertain. (44). At the present time, DXA remains the best method for confirming the presence of osteoporosis, and bone density measurement may be used as part of fracture risk assessment for selected individuals, as well as for those potentially having secondary osteoporosis, for example those on glucocorticoid (steroid) treatment.

When osteoporosis is present, various interventions can help to reduce the chance of further fractures. Preventive interventions include lifestyle and environmental changes as well as drug therapies. The Osteoporosis Society of Canada has endorsed public health recommendations, such as increased calcium and vitamin D intake, regular weight-bearing exercise, and smoking cessation (45). Adequate calcium intake has been shown to delay bone loss in the elderly. Physical activity promotes bone deposition, and physical activity trials have demonstrated increased maintenance of bone mass in people with osteoporosis (13). High impact exercises, such as weight training, are effective for maintaining bone mass (13). However, more trials demonstrating the impact of diet and lifestyle interventions are necessary to support the scientific evidence. Environmental interventions are discussed in the Fall and Fracture Prevention section of this document.

There are 6 drugs approved for the management of osteoporosis. The actual efficacy of these drugs is the subject of ongoing debate and evolving research. Some of these drugs have significant side effects, and in some cases, the long-term effects are still unknown. This document does not attempt to explain the benefits and disadvantages of each of the available drugs. In B.C., the Therapeutics Initiative provides an evaluation of some of the drugs used in the treatment of osteoporosis (newsletters can be found online at the Therapeutics Initiative home page, www.ti.ubc.ca). Peer-reviewed studies on many drug therapies are available in scientific journals, such as The New England Journal of Medicine and The Lancet. Indicated drugs include estrogen, selective estrogen receptor modifying drugs (SERMS), bisphosphonates, and calcitonin. Some of these drugs have been found to reduce certain types of fractures, but not others, so physicians should be alert to new developments.

Access to appropriate drug therapies is an important part of a plan to prevent future fractures when osteoporosis is present, as are modifications in diet, lifestyle, and environment.

The following section discusses fall prevention, an essential part of fracture prevention for seniors with and without osteoporosis.

Fall and Fracture Prevention

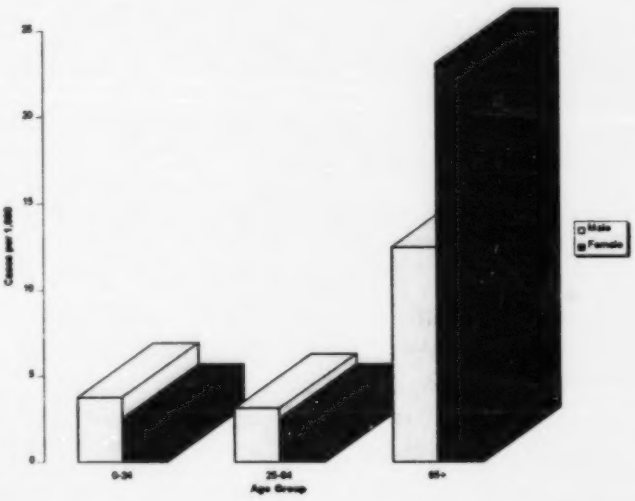
Statistics

Falls are the **greatest** risk factor for serious injury and fractures in elderly persons, and of those who experience fractures, less than 50% have underlying osteoporosis as a contributing factor. Thus, fall prevention is a fundamental component of a fracture prevention strategy potentially beneficial to people with and without osteoporosis.

Poor recovery following hip fracture is a common cause for admission to a nursing home and, thus, a loss of autonomy for a senior.

Recent figures show that, in Canada, each year, approximately one out of three seniors will fall. Of those falling, 25% will suffer serious injury. In 1998, the rate of hospitalisations due to falls for B.C. women over the age of 65 was 2.3% (46). While this rate has remained fairly stable over the past decade, the actual number of hospitalisations has increased steadily with the increasing population of people over the age of 65. Important to note is that the incidence of falling rises dramatically over the age of 75. Figure 3 shows the incidence of hospitalisations due to falls across the lifespan. Further, falls are even more likely for elderly persons residing in nursing homes (12). For example, in the 1998-1999 fiscal year, falls resulted in 1,174 transfers from nursing homes and other extended care facilities to hospitals (47). Hip fracture is the most serious and debilitating fall-related injury; an estimated 97% of all hip fractures result from falls (48). Hip fractures cause the highest morbidity and are associated with the highest cost to the health care system, although the incidence of spinal and wrist fractures is actually greater (41).

Figure 3: Hospitalisations due to falls across the lifespan (B.C. Average per 1,000 population), 1993/1994.



Risk Factors and Recommendations for Prevention

Biological, environmental, behavioural, and social factors have all been found to affect the risk of falls in seniors (12) (see Table 2 for a listing), and there is compelling evidence that attention to these risk factors will prevent falls and fractures.

A two-level preventive approach is recommended to deal with minimising fall risk and, thus, injuries associated with falls: primary and secondary prevention (49). Primary prevention concerns reducing the

Table 2: Risk Factors for Falls

Biological	Behavioural/Social	Environmental
Poor visual acuity	Altered mental status	Winter conditions
Dizziness/poor balance	Alcohol use	Slippery floors
Movement problems	Inattention	Inadequate railings
Medications (benzodiazepines, anti-anxiety drugs, sleeping medications)	Poor footwear	Inadequate lighting
Stroke		Uneven ground
Age, Gender		

With respect to primary prevention, many risk factors for falls are avoidable or have a simple solution. For example, in this province, there are excellent data showing the epidemic overprescription of benzodiazepines and other anti-anxiety and sleeping medications in our seniors. These drugs are strongly associated with falls, and subsequent fractures (50, 51, 52, 53, 54). Addressing the overuse of these medications in our population at risk for falls could significantly reduce the occurrence of falls.

Other biological as well as behavioural/social risk factors can be addressed through the assessment and counselling of seniors. These include increasing seniors' awareness of fall risks, improving footwear, ensuring visual correction, adjusting blood pressure and other medications, and developing low-impact exercise programs to improve balance (13, 52). Exercise programs, in particular, can be helpful not only because of increased strength and balance, but also as a result of the greater confidence that results (55).

British Columbia has led the way in Canada in addressing environmental factors that play a significant role in falls and resulting fractures. For example, lack of attention to sidewalk maintenance has been shown to be a major contributing factor to falls among the elderly (56). Developing a supportive community approach to addressing these factors has been successful in fall and fracture prevention (48). Eliminating environmental risks, such as throw rugs, and ensuring proper footwear can also significantly reduce the risk of falls. Special attention should be paid to the type of living situation a person has, or more directly, the level of functioning of the individual. Interventions may be different depending on whether an individual is living independently or in different types of community-based environments (49).

Secondary prevention strategies, focussing on preventing injury *when* a fall occurs, have shown promise. A study of fall-related hip fractures revealed that 84% of all these fractures resulted from falling directly onto the side in question (57). One suggestion resulting from this finding is that protective hip padding may be beneficial. Another way to combat the effect of falls is to teach the elderly to fall effectively. Using the arm to break a fall instead of falling directly onto the hip may help to decrease the possibility of injury or at least decrease the severity of injury (58).

Summary

In summary, the results of research in the area of bone health, osteoporosis, and fall and fracture prevention are surprisingly uniform. Whether the focus is on nutrition, physical activity, or other interventions, virtually all of the comprehensive studies conclude that **prevention** is the optimal method for decreasing the social and economic burden of osteoporosis. While treatments for osteoporosis are becoming increasingly successful, the fact remains that with attention to good bone health throughout life, and fall prevention later in life, the need for medical treatment can be greatly reduced.

The Health Promotion Approach

What is Health Promotion?

Goals of Health Promotion

Health promotion is "the process of enabling people to increase control over, and to improve their health." A holistic approach designed to address the entire range of factors that influence health, health promotion encompasses all aspects of health and health care. This approach can positively affect the health of the entire population (59, 60).

Strategies Used for Health Promotion

In order to meet the goals of health promotion, five main strategies are used. These strategies, identified by the Ottawa Charter (61), are designed to address the needs of the population in the most constructive, economical, and healthy way.

- Building healthy public policy
  This strategy places health on the agenda of policy makers in all sectors, at all levels. It combines approaches using legislation, fiscal measures, taxation, and organisational change. In the case of bone health and fracture prevention, it results in changes, such as: appropriate protocol for DXA testing, smoking bylaws, vitamin D supplementation of milk, and sidewalk maintenance bylaws.
- Creating supportive environments
  Through encouraging communities and individuals to take care of each other, this strategy links people to their environment and provides more support for those in need. For example, the Women's Health in Midlife Project, a joint initiative of

the B.C. Women's Hospital and Health Centre and the Women's Health Bureau, helps to create a supportive environment for women in midlife by providing opportunities for them to learn about health issues that concern them.

- Strengthening community action

  By encouraging communities to work together to set priorities, plan, make decisions, and implement strategies for better health, public participation is strengthened and empowers communities to take control of their own health. For example, the North Shore Women's and Seniors' Advisory Groups, provide an arena for community members to contribute to the decisions of the local Health Board.

- Developing personal skills

  Educating individuals about health matters and providing them with sufficient information to make informed decisions can increase control over personal health. This can be accomplished through initiatives, such as health education programs, doctor/patient education, and health fairs. For example, the Osteofair, hosted by B.C. Women's Hospital and Health Centre, educates the public about bone health, fracture prevention, and osteoporosis.

- Reorientation of health services

  By differentiating between people who need medical attention and people who just need more information, better service can be provided for those in need, and unnecessary use of medical resources can be avoided. This can accomplished in many ways, such as providing health fairs for information, improving the referral system for those with major problems, and having each health region develop a bone health strategy.

Health Promotion in Canada

Canada has been a leader in the area of health promotion for the last 20 years. In 1974, a document entitled *A New Perspective on the Health of Canadians* was released highlighting the impact of lifestyle on health status. Health Canada has recently updated this perspective (60). Over the past two decades, health promotion efforts, such as the Active Living Policy and the Physical Activity Guide, have successfully improved the health behaviours of Canadians (62, 63). For example, between 1981 and 1995, the number of physically active people has increased, while the number of smokers has decreased (60).

Health promotion efforts have also been successful at the provincial level. Examples of successful initiatives in British Columbia are *Feed our Future, Secure our Health* (64), on improving nutrition, and *B.C. Setting the Pace* (65), on increasing physical activity, both prepared by the Heart Health Coalition.

Why use a health promotion approach for bone health and fracture prevention?

Osteoporosis is a population health issue. It affects a larger segment of the population than many other diseases. As the population ages, the prevalence of osteoporosis will

increase dramatically, as will its cost for society, in terms of quality of life, as well as dollars. While there is no cure for osteoporosis, it is preventable. By taking a health promotion approach across the lifespan that focuses on promoting healthy lifestyles and preventing fractures, the prevalence of osteoporosis and the incidence of fractures can be reduced. This would result in improved the quality of life for people of all ages and greatly reduced cost to the health care system.

The primary goals in optimising bone health and preventing fractures are to (66):

- Maximise the development of healthy bones
- Maintain healthy bone quality and quantity
- Prevent loss of bone
- Minimise the risk of fracture

Meeting these goals requires a focus on bone health throughout life and on fracture prevention initiatives in the second half of life. Health promotion initiatives can be implemented across the entire lifespan. Furthermore, many of the determinants of osteoporosis include lifestyle behaviours, which can be significantly improved through educational efforts: a main focus of health promotion strategies.

Health promotion is very practical for the child/adolescent population since school-based programs can be used to encourage the adoption of healthy lifestyle behaviours early in life. When applied to the older population, fall prevention as a health promotion strategy can make a significant contribution to a reduction in the incidence of fractures.

Since the majority of bone is acquired during childhood and adolescence, and since habits adopted at a young age are likely to remain throughout life, promoting lifestyles that enhance bone health for children and adolescents is the best strategy for improving the outlook for good bone health later in life. Finally, efforts towards educating and changing peoples' lifestyle behaviours will not only improve bone health, but will also affect the prevalence of other chronic health problems, such as heart disease.

Considering all these factors, it seems appropriate to adopt a population health promotion model to address the issue of bone health and fracture prevention. The following section discusses the creation of such a model.

Mapping Bone Health and Fracture Prevention Initiatives in B.C.

There are many health promotion initiatives currently in place in British Columbia. The chart on pages 22 and 23 lists examples of initiatives with impact on bone health. Each program has been categorised according to the health promotion strategy being used, and within each category, programs have been arranged according to the age group they serve. Programs in the lifespan category affect those in all age categories. Programs have additionally been grouped into the area of bone health they affect (nutrition, physical activity, fall prevention, and medical services). In some areas, programs are not really necessary. For example, fall prevention is not an important issue for children. The categories that do not need to be addressed have been greyed out in the chart.

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Some of these programs have been specifically designed to address bone health. For example, the B.C. Dairy Foundation School Milk program provides milk and milk-centred activities for elementary schools. Other programs, such as Heart Smart Kids (a curriculum program for elementary school teachers that promotes physical activity, nutrition, and being smoke-free), are focussed on other health issues but encourage habits that are also beneficial for bone health.

The inventory provided with this report explains the programs named on the chart. An effective bone health and fracture prevention strategy will build on pre-existing initiatives, as well as implement new programs where necessary.

The workbook accompanying this report guides regions and communities through the process of mapping their own bone health initiatives. This process should allow regions/communities to identify areas that need improvement and to develop a bone health strategy by building on the strengths of existing programs. For example, a community may be concentrating all of their resources on medical services for the middle/late adulthood age group. However, simply by including a fall risk assessment as part of this medical service and then providing follow-up services to address the identified risk factors, a community could make a significant difference in the lives of many seniors and drastically reduce expenditures associated with falls.

The inventory of B.C. programs is not exhaustive, but can be used in two ways. First, communities not taking part in an initiative can use contact information to inquire about starting a program in their area. Secondly, planners can use the program descriptions to create similar initiatives, specific to their community. Through use of this inventory, community plans for promoting bone health and fracture prevention can be created without the need to invest scarce resources into program development, when similar initiatives already exist.

Chart Legend:

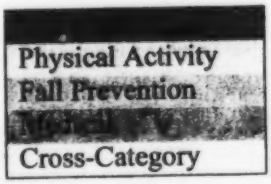

Chart 1: Programs Affecting Bone Health in British Columbia
*A full explanation of all programs are listed alphabetically in the Inventory.

Age Group	Public Policy	Supportive Environment	Community Action	Personal Skills	Health Services
Lifespan	[redacted]	[redacted]	-Dairyland Fortified Milk Products -Heart and Stroke Foundation -B.C. Lung Association	[redacted]	[redacted]
	-Physical Activity Guide	-Promotion Plus	-Boys/Girls Clubs/Activity Programs -Sports Clubs -Community Recreation Programs -YW/MCA Fitness Programs		
	-Bone Density Protocols	-Shoppers Drug Mart HealthForums -B.C. Doctors Stop Smoking Program		[redacted]	[redacted]
Childhood	[redacted]	[redacted] -Caring for Kids	-School Milk Program -B.C. School Sports	[redacted] -Heart Smart Kids	[redacted]
		-Premier Sports Awards -Kidsport Fund -Night Hoops	-Walk a Child to School -Jump Rope for Heart	-Lungs for Life	
	-B.C. Tobacco Strategy	[redacted]	[redacted]	[redacted]	-Endocrine Clinic

Adolescence and Young Adulthood		-B.C. Tobacco Strategy		-B.C. Games	-B.C. School Sports	-Girls in Action -On the Move -Evening the Odds	-Go Girls	
			-Eating Disorders Resource Centre of B.C.			-Kick the Nic -H.I.P.		-Endocrine Clinic
Late Adulthood			-B.C.R.P.A. Fitness Leadership		-North Shore Women's and Seniors' Advisory Groups	-Osteofit -North Shore Keep Well Initiative -Joints in Motion -Hearts in Motion -Changing Aging		B.C. Reproductive Care Respirato
	-Sidewalk Maintenance Bylaws -Building Codes		-Adult Injury Management Summit (AIMS)					-Providence Health Care Fracture and Fall Prevention Program -Paris Orthotics -The Right Shoe Company
	-Environmental Smoke Requirements		-Women's Health in Midlife Project	-OSTOP -The Wellness Centre		-Osteofair		-Bone Density Diagnostic Services -BC Women's Osteoporosis program

Recommendations and Conclusions

Despite the growing ageing population, the burden of osteoporosis and fractures on the health care system can be greatly reduced with the use of foresight and long-term planning. The purpose of this document is to bring this fact to the attention of policy-makers and decision-makers, to encourage long-term, comprehensive and focussed planning for bone health, and to provide direction for such plans.

Based on the research outlined in this document, the Bone Health and Fracture Prevention Steering Committee makes the following general recommendations to the Ministry of Health:

- This report should be distributed to community planners and regional policy makers for use as a tool in creating a strategic plan for bone health and fracture prevention.

- The Ministry of Health should actively support health authorities in B.C. taking action in planning, implementing, and evaluating bone health and fracture prevention strategies.

- Implementation of strategies or programs that enhance the impact of pre-existing initiatives on bone health and fracture prevention would be cost-effective.

- Child and youth health initiatives that promote healthy lifestyle practices, such as physical activity, good nutrition, and avoidance of substance abuse, should be funded. This will target the age group at a critical period in bone development, and could potentially reduce future osteoporosis-related health care costs. Corollary benefits to other important areas of health would also result from such a strategy.

- Recognising the fact that over 50% of hip fractures occur in patients who do not have osteoporosis, the Ministry of Health should foster and facilitate the implementation of fall prevention strategies, especially among seniors.

- The Ministry of Health is encouraged to implement and facilitate policy, which will ensure that vitamin D and calcium supplementation in continuing and extended care facilities are addressed across this part of the health care system.

- Continuing research in this area of health is important to maintain up-to-date knowledge. The Ministry of Health is encouraged to support and facilitate innovative research in the area of bone health and fracture prevention.

References

1. B.C. Ministry of Health and Ministry Responsible for Seniors (2000). *Hip Fractures.* Health Data Warehouse.

2. B.C. Ministry of Health and Ministry Responsible for Seniors (2000). Hos*pitalisations due to external causes.* Local Accident Reporting System.

3. Kannus, P., Haapasalo, H., Sankelo, M., Sievanen, H., Pasanen, M., Heinonen, A., Oja, P. & Vuori, I. (1995). Effect of starting age of physical activity on bone mass in the dominant arm of tennis and squash players. *Annals of Internal Medicine, 123*(1): 27-31.

4. McKay, H.A., Petit, M.A., Schutz, R.W., Prior, J.C., Barr, S.I. & Khan, K.M. (2000). Augmented trochanteric bone mineral density after modified physical education classes: A randomized, school-based exercise intervention study in prepubescent and early pubescent children. *Journal of Pediatrics, 136*(2): 156-162.

5. McKay, H.A., Bailey, D.A., Mirwald, R.L., Davison, K.S. & Faulkner, R.A. (1998). Peak bone mineral accrual and age of menarche in adolescent girls: A six- year longitudinal study. *Journal of Pediatrics, 133*(5): 682-687.

6. Osteoporosis Society of Canada. *What is osteoporosis?* Retrieved January 5th, 2001 from the World Wide Web: http://www.osteoporosis.ca/OSTEO/D01-01.html

7. Parfitt, A.M. (1994). The two faces of growth: Benefits and risks to bone integrity. *Osteoporosis International, 4*: 382-398.

8. Frost, H.M. (1987). Bone "mass" and the "mechanostat": A proposal. *Anatomical Record, 219*: 1-9.

9. Martin, A.D., Bailey, D.A., McKay, H.A. & Whiting, S. (1997). Bone mineral and calcium accretion during puberty. *American Journal of Clinical Nutrition.* 66: 611-615.

10. Arlot, M.E., Sornay-Rendu, E., Garnero, P., Vey-Marty, B. & Delmas, P.D. (1997). Apparent pre- and postmenopausal bone loss evaluated by DXA at different skeletal sites in women: The OFELY cohort. *Journal of Bone and Mineral Research, 12*(4): 683-690.

11. Bonjour, J.P., Carrie, A.L., Ferrari, S., Clavien, H., Slosman, D., Theintz, G. & Rizzoli, R. (1997). Calcium-enriched foods and bone mass growth in prepubertal girls: A randomized, double-blind, placebo-controlled trial. *Journal of Clinical Investigation, 99*(6): 1287-1294.

12. Szajcz, M.(Ed), Olszynksi, W., Frketic, J., Braithwaite, K., Page, A. & Davis, G. (1999). *Osteoporosis partnership program: A healthcare professional based educational program.* M. Szajcz Publications, Saskatoon, Saskatchewan.

13. Osteoporosis Prevention, Diagnosis, and Therapy. *NIH Consensus Statement Online 2000 March 27-29*; [2000, May, 15]; 17(1): 1-36.

14. Lee, W.T.K., Leung, S.S.F., Wang, S.H., Xu, Y.C., Zeng, W.P., Lau, J., Oppenheimer, S.J. & Cheng, J.C.Y. (1994). Double-blind, controlled calcium supplementation and bone mineral accretion in children accustomed to a low-calcium diet. *American Journal of Clinical Nutrition, 60*: 744-750.

15. Lee, W.T.K., Leung, S.S.F., Leung, D.M.Y., Wang, S.H., Xu, Y.C., Zeng, W.P. & Cheng, J.C.Y. (1997). Bone mineral acquisition in low calcium intake children following the withdrawal of calcium supplement. *Acta Paediatrica, 86*: 570-576.

16. Lloyd, T., Andon, M.B., Rollings, N., Martel, J.K., Landis, J.R., Demers, L.M., Eggli, D.F., Kieselhorst, K. & Kulin, H.E. (1993). Calcium supplementation and bone mineral density in adolescent girls. *Journal of the American Medical Association, 270*(7): 841-844.

17. Dawson-Hughes B., Harris, S.S., Krall, E.A. & Dallal, G.E. (1997) Effect of calcium and vitamin D supplementation on bone density in men and women 65 years of age or older. *New England Journal of Medicine, 337*(10): 670-676.

18. Dawson-Hughes, B., Dallal, G.E., Krall, E.A., Sadowski,, L., Sahyoun, N. & Tannenbaum, S. (1990). A controlled trial of the effect of calcium supplementation on bone density in postmenopausal women. *New England Journal of Medicine, 323*(13): 878-883.

19. Weinstock, M.A. (1999). Do sunscreens increase or decrease melanoma risk: An epidemiologic evaluation. *Journal of Investigative Dermatology, 4*(1): 97-100.

20. Holick, M.F. (1996). Vitamin D and bone health. *Journal of Nutrition, 126*(4 Suppl): 1159S-1164S).

21. Castaneda, C., Charnley J.M., Evans W.J. & Crim, M.C. (1995). Elderly women accommodate to a low-protein diet with losses of body cell mass, muscle function, and immune response. *American Journal of Clinical Nutrition, 62*(1): 30-39.

22. Schurch, M.A., Rizzoli, R., Slosman, D., Vadas L., Vergnaud, P. & Bonjour, J.P. (1998). Protein supplements increase serum insulin-like growth factor-I levels and attenuate proximal femur bone loss in patients with recent hip fracture. A randomized, double-blind, placebo-controlled trial. *Annals of Internal Medicine, 128*(10): 801-9.

23. Petit, M.A., Kramer, L., Hitchcock, C., Barr, S.I., McKay, H.A., Vigna, Y.M. & Prior, J.C. (unpublished). *Weight cycling – A population risk factor for osteoporosis: Baseline data from the B.C. Centre of the Canadian Multicentre Osteoporosis Study.*

24. Gilsanz, V., Roe, T.F., Mora, S., Costin, G. & Goodman, W.G. (1991). Changes invertebral bone density in Black girls and White girls during childhood and puberty. *New England Journal of Medicine, 325*(23), 1597-1600.

25. Bertron, P., Barnard, N.D. & Mills, M. (1999). Racial bias in federal nutrition policy, Part I: The public health implications of variations in lactase persistence. *Journal of the National Medical Association, 91*(3), 151-157.

26. Davis, J.W., Novotny, R., Ross, P.D. & Wasnich, R.D. (1994). The peak bone mass of Hawaiian, Filipino, Japanese, and white women living in Hawaii. *Calcified Tissue International, 55*(4), 249-252.

27. Ito, M., Lang, T.F., Jergas, M., Ohki, M., Takada, M., Nakamura, T., Hayashi, K. & Genant, H.K. (1997). Spinal trabecular bone loss and fracture in American and Japanese women. *Calcified Tissue International, 61*(2), 123-128.

28. Zhao X. & Chen X. (1992). Diet and bone density among elderly Chinese. *Nutrition Reviews, 50*(12): 395-397.

29. Cummings, S.R., Xu, L., Chen, X., Zhao, X., Yu, W. & Ge. Q. (1994). Bone mass, rates of osteoporotic fractures, and prevention of fractures: Are there differences between China and Western countries? *Chinese Medical Sciences Journal, 9*(3), 197-200.

30. Theobald, T.M., Cauley, J.A., Gluer, C.C., Bunker, C.H., Ukoli, F.A.M. & Genant, H.K. (1998). Black-White differences in hip geometry. *Osteoporosis International, 8*(1), 61-67.

31. Barr, S.I. & McKay, H.A. (1998). Nutrition, exercise, and bone status in youth. *International Journal of Sport Nutrition, 8:* 124-142.

32. Stallings, V.A. (1997). Calcium and bone health in children: A review. *American Journal of Therapeutics, 4*(7-8): 259-273.

33. Morris, F.L., Naughton, G.A., Gibbs, J.L., Carlson, J.S. & Wark, J.D. (1997). Prospective ten-month exercise intervention in premenarcheal girls: Positive effects on bone and lean mass. *Journal of Bone and Mineral Research, 12*(9): 1453-1462.

34. Heinonen, A., Sievanen, H., Kannus, P., Oja, P. & Vuori, I. (1996). Effects of unilateral strength training and detraining on bone mineral mass and estimated mechanical characteristics of the upper limb bones in young women. *Journal of Bone and Mineral Research, 11*(4): 490-501.

35. Friedlander, A.L., Genant, H.K., Sadowsky, S., Byl, N.N. & Gluer, C.C. (1995). A two-year program of aerobics and weight training enhances bone mineral density of young women. *Journal of Bone and Mineral Research, 10*(4): 574-585.

36. Khan, K.M., Bennell, K.L., Hopper, J.L., Flicker, L., Nowson, C.A., Sherwin, A.J., Crichton, K.J., Harcourt, P.R. & Wark, J.D. (1998). Self-reported ballet classes undertaken at age 10-12 years and hip bone mineral density in later life. *Osteoporosis International, 8:* 165-173.

37. Slemenda, C.W., Reister, T.K., Hui, S.L., Miller, J.Z., Christian, J.C. & Johnston, C.C., Jr. (1994). Influences on skeletal mineralization in children and adolescents: Evidence for varying effects of sexual maturation and physical activity. *Journal of Pediatrics, 125:* 201-207.

38. Canadian Association for the Advancement of Women in Sport. *The on the move concept*. Retrieved June 17th, 2000 from the World Wide Web: http://www.caaws.ca/onthemove/OTMWeb/concept.htm.

39. Canadian Association for the Advancement of Women in Sport. *Why bother?* Retrieved June 17th, 2000 from the World Wide Web: http://www.caaws.ca/onthemove/OTMWeb/bother.htm

40. Prevention and management of osteoporosis: Consensus statements from the Scientific Advisory Board of the Osteoporosis Society of Canada. (1996). *Canadian Medical Association Journal, 155*(7, suppl): 921-965.

41. Riggs, B.L. & Melton, L.J., III (1995). The worldwide problem of osteoporosis: Insights afforded by epidemiology. *Bone, 17*(5, suppl): 5055-5115.

42. Consensus Development Conference: Diagnosis, prophylaxis, and treatment of osteoporosis. (1993). *American Journal of Medicine, 94*(6): 646-650.

43. B.C. Office of Health Technology Assessment (1997). *Bone mineral density testing: Does the evidence support its selective use in well women?* University of British Columbia.

44. MedicineNet.com: Smart Medicine. *Bone density scan.* http://www.medicinenet.com (Accessed 20 November 2000) from the World Wide Web.

45. Osteoporosis Society of Canada. *Prevention: Building better bones.* Retrieved January 8th, 2001 from the World Wide Web: http://www.osteoporosis.ca/OSTEO/D02-01.html

46. B.C. Ministry of Health and Ministry Responsible for Seniors (2000). *Hospitalisation cases due to falls*. LAN Accident Reporting System. Office for Injury Prevention.

47. B.C. Ministry of Health and Ministry Responsible for Seniors (2000). *Hospitalized transfers from intermediate and extended care to acute care facilities due to falls.* Morbidity files, Decision Support System.

48. Gallagher, E.M., Scott, V. & Mills, M. (1999). *Adult Injury Management: Preventing unintentional injuries among older adults and persons with disabilities.* University of Victoria, Victoria, B.C.

49. Stevens, J.A. & Olson, S. (2000). Reducing falls and resulting hip fractures among older women. *Morbidity and Mortality Weekly Report, 49*(RR2): 3-12.

50. Costa, A.J. (1991). Preventing falls in your elderly patients. *Postgraduate Medicine, 89*(1): 139-142.

51. Hemmelgarn, B., Suissa, S., Huang, A., Boivin, J.F. & Pinard, G. (1997). Benzodiazepine use and the risk of motor vehicle crash in the elderly. *Journal of the American Medical Association, 278*(1): 27-31.

52. Kempton, A., van Beurden, E., Sladden, T., Garner, E. & Beard, J. (2000). Older people can stay on their feet: Final results of a community-based falls prevention programme. *Health Promotion International, 15*(1): 27-33.

53. Koski, K., Luukinen, H., Laippala, P., & Kivela, S.L. (1996). Physiological factors and medications as predictors of injurious falls by elder people: A prospective population-based study. *Age and Ageing, 25*: 29-38.

54. Neutel, C.I., Hirdes, J.P., Maxwell, C.J. & Patten, S.B. (1996). New evidence on benzodiazepine use and falls: The time factor. *Age and ageing, 25*: 273-278.

55. Campbell, A.J., Robertson, M.C., Gardner, N.M., Norton, R.N. & Buchner, D.M. (1999). Falls prevention over 2 years: A randomized controlled trial in women 80 years and older. *Age-Ageing, 28*(6): 513-8.

56. Gallagher, E.M. & Scott, V. (199x). *Taking steps: Modifying pedestrian environments to reduce the risk of missteps and falls.* University of Victoria School of Nursing, Victoria, B.C.

57. Hopkinson-Wooley, J.A. & Parker, M.J. (1998). Fractures of the hip: Does the type of fall really affect the site of the fracture? *Injury, 29*(8): 585-7.

58. Sabick, M.B., Hay, J.G., Goel, V.K. & Banks, S.A. (1999). Active responses decrease impact forces at the hip and shoulder in falls to the side. *Journal of Biomechanics, 32*(9): 993-8.

59. Hamilton, N. & Bhatti, T. (1996). *Population health promotion: an integrated model of population health and health promotion.* Health Promotion Development Division, Health Canada, Ottawa, Ontario.

60. Health Canada (1999). *Toward a healthy future: Second report on the health of Canadians*. Publications, Health Canada, Ottawa, Ontario.

61. Health and Welfare Canada and the Canadian Public Health Association (1986). *Ottawa charter for health promotion.* World Health Organization.

62. Bercovitz, K.L. (1998). Canada's Active Living policy: A critical analysis. *Health Promotion International, 13*(4): 319-328.

63. Canadian Society for Exercise Physiology (1998). *Canada's physical activity guide to healthy active living.* Health Canada, Ottawa.

64. Heart Health Coalition (1997). *Feed our future, secure our health.* Heart and Stroke Foundation, Vancouver, B.C.

65. Heart Health Coalition (1997). *B.C. setting the pace.* Heart and Stroke Foundation, Vancouver, B.C.

66. The Canadian consensus conference on menopause and osteoporosis. (1998). Reprinted in *Journal of the Society of Obstetricians and Gynaecologists of Canada, 20*(13, 14), 1-64.

Appendix

Protocol for Bone Density Measurement

The Medical Services Commission (BCMA) created the following policies as a guide to appropriate use of DXA. The recommendations became effective May 1, 1999.

1. DXA should not be used as a screening procedure in any age group or as part of routine perimenopausal evaluation.

2. DXA should not be performed to confirm osteoporosis if patients have low-trauma fractures and other pathologies have been ruled out.

3. DXA should only be performed when results are likely to alter patient care.

4. If DXA is justified by Recommendations 2 or 3, baseline measurements of the lumbar spine and proximal femur should be taken.

5. Follow-up measurements should not be performed unless medically required and not within two years of the original measurement, with the following exceptions:
   - patients receiving high dose corticosteroids
   - patients receiving drug therapy for osteoporosis

Recommended Calcium Intake

Age	Daily Calcium Requirements
0-4 months	250 mg
5-12 months	400 mg
1-3 years	550 mg
3-8 years	800 mg
9-18 years	1300 mg
19-50 years	1000 mg
50 + years	1200 mg